## Integrated Rate Law

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- This law is used when you are given _____ & _____
- Yesterday (for the differential rate law) you were given a graph of concentration & rate

## Rate Law Summary

**TABLE 12.6 Summary of the Kinetics for Reactions of the Type aA → Products That Are Zero, First, or Second Order in [A]**

| | Order | | |
|---|---|---|---|
| | *Zero* | *First* | *Second* |
| Rate Law: | Rate = $k$ | Rate = $k[A]$ | Rate = $k[A]^2$ |
| Integrated Rate Law: | $[A] = -kt + [A]_0$ | $\ln[A] = -kt + \ln[A]_0$ | $\frac{1}{[A]} = kt + \frac{1}{[A]_0}$ |
| Plot Needed to Give a Straight Line: | $[A]$ versus $t$ | $\ln[A]$ versus $t$ | $\frac{1}{[A]}$ versus $t$ |
| Relationship of Rate Constant to the Slope of Straight Line: | Slope = $-k$ | Slope = $-k$ | Slope = $k$ |
| Half-Life: | $t_{1/2} = \frac{[A]_0}{2k}$ | $t_{1/2} = \frac{0.693}{k}$ | $t_{1/2} = \frac{1}{k[A]_0}$ |

## Determining the order:

- You will be given a chart of concentrations and time
- Make another column for _____ and _____
- Use a few data points to find the slope of [A] vs time
- Do the same for ln[A] vs time
- Do the same for 1/[A] vs time
- The one that gives the straightest line gives the reaction order

## Example

Determine the rate law & the value of k for the following reaction:

$2N_2O_5 \rightarrow 4NO_2 + O_2$

| $[N_2O_5]$ | Time (s) |
|---|---|
| 0 | 0 |
| 0.0707 | 50 |
| 0.0500 | 100 |
| 0.0250 | 200 |
| 0.0125 | 300 |
| 0.00625 | 400 |

## ½ life

- Time it takes for ½ the reactant to be gone
- What was the ½ life for the last problem?

## Example

Determine the rate law & the value of k for the following reaction: $2C_4H_6 \rightarrow C_8H_{12}$

| $[C_4H_6]$ | Time (s) |
|---|---|
| 0.01 | 0 |
| 0.00625 | 1000 |
| 0.00467 | 1800 |
| 0.00370 | 2800 |
| 0.00313 | 3600 |
| 0.00270 | 4400 |
| 0.00241 | 5200 |
| 0.00208 | 6200 |

## Example

- What is the ½ life for the last reaction?

## Another example

- A 1st order reaction is 38.5% complete in 480 seconds
  a. Calculate the rate constant
  b. Calculate the value of the ½ life
  c. How long will it take for the reaction to go 25%
  d. 75%
  e. 95%

## Last example

- If the ½ life is 45 seconds, how much is left after 225 seconds?